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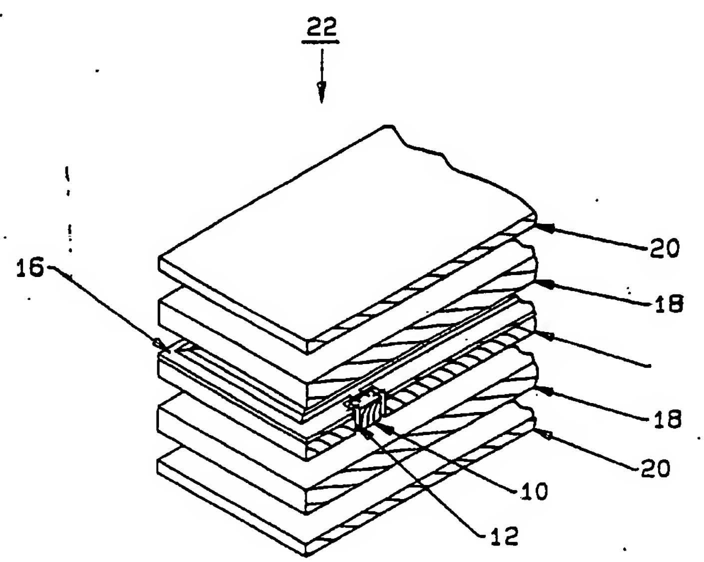
**(54) Title:** METHOD FOR THE MANUFACTURE OF AND STRUCTURE OF A LAMINATED PROXIMITY CARD




**(57) Abstract**

A proximity access card is manufactured by disposing a printed circuit element (16) onto a core layer (14) and placing the integrated circuit which is coupled to the printed circuit element into a cavity (12) defined in the core layer. The cavity is defined through the core layer and completely circumscribes the integrated circuit so that little or no portion of the integrated circuit, other than its leads, are exposed above the surfaces of the core layer. A graphics layer (18) is then disposed on each side of the core layer. A protective layer (20) is then disposed on the outside of each of the graphic layers. The multiple layers are then laminated by pressure and heat to form a bonded integrated card. The card may be mass-produced from continuous films.

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# METHOD FOR THE MANUFACTURE OF AND STRUCTURE OF A LAMINATED PROXIMITY CARD

## Background of the Invention

### 1. Field of the Invention

The invention relates to the field of laminated cards used for interactive applications such as access cards, control cards, identification cards, credit cards, or labels, and in particular relates to a method of manufacture and a structure for a laminated proximity card wherein an object is accessed without insertion of the key card but merely its proximate position.

### 2. Description of the Prior Art

Access cards for opening locked gates, doors and the like are well known and have become virtually universal in the United States and elsewhere for controlled access to restricted parking structures or lots and in many cases to the common areas in security controlled apartment buildings. Many different designs for access cards have been devised and they are generally based on some type of magnetic or metallic pattern which is sensed and embedded in the interior of the laminated card.

However, such access or key cards typically require their insertion into a reading device or placement directly upon a reading device, since the embedded metallic or magnetic pattern in the card must be placed in contact with or in very close proximity to a sensor in order for the pattern to be reliably decoded.

The use and insertion of such access cards into card readers is beset with a number of problems. Firstly, in some cases the interior of the reader and sensors must be open to exterior access. This may result in problems of weathering, wetness and contamination from the injection of elements, foreign objects and soiled cards. In addition thereto, the requirement of physical insertion or placement of the card on or into the reading device limits and restricts the placement of the reading device, particularly when used in connection with vehicles which are restricted to travel on a roadway, path or rail. As a result, the range of applications to which such key access cards have been made has been limited both by commercial and human factors.

In response thereto, the art has devised a number of designs, both in cards and readers, which do not require physical insertion of the card on or into a reading device, namely proximity cards. Proximity cards are in essence a circuit which communicates with the sensor through electromagnetic coupling. The "card" includes an antenna or

loop element coupled to a circuit, typically a digital circuit. Power to the circuit is inductively coupled through the antenna or loop which, when powered up, responds by generating a coded signal which is again transmitted through the loop or antenna to a sensor. The sensor can then respond to the coded signal to permit or deny access or to make such other recordings or accountings as may be expedient.

A typical example of such prior art interactive cards can be seen in BLISS, "Electrical Verification and Identification System", U.S. Patent 3,876,865 (1975); WALTON, "Identification System", U.S. Patent 4,223,830 (1980); ELLINGBOE, "Active Electrical Card Device", U.S. Patent 3,6237,994 (1972); and POETKER et al., "Data Processing Card System and Method of Forming Same", U.S. Patent 4,539,472 (1985). However, many of these card systems are not true proximity cards in that they require coupling of internal electrical leads to edge connectors on the card. Even if they are true proximity cards, such prior art cards are characterized by undue thickness or size of the card.

The typical proximity card has a loop antenna laid by conventional printed circuit board techniques on a piece of circuit board about the two-dimensional size of a standard credit card. However, the thickness of the circuit board may be substantially greater than many credit cards. The

circuit board is also typically rigid and breakable and does not laminate or adhere well to most substances such as vinyl. The integrated circuit is then electrically coupled to the loop antenna and placed either on top of the printed circuit board, according to conventional circuit board fabrication technology, or placed on or in a recess in a printed circuit board. The printed circuit board is then disposed in a hollowed-out cavity defined in the core layer. Additional layers are placed and laminated on the integrated circuit, core layer and printed circuit. The additional layers carry graphics or provide an encapsulating or protective cover over the core layer, integrated circuit and printed circuit board. The layers are laminated with heat and/or pressure.

However, in most lamination processes the heat and pressure which may be applied to the integrated circuit is often sufficient to cause failure of the integrated circuit or its electrical connection to the printed circuit board. The result is that not only is the access "card" much thicker than desirable and utilizes an expensive printed circuit board, but also a significantly lower yield rate is realized due to the occasional loss of function suffered by the integrated circuit during the lamination process. The unit cost of such proximity cards is thus commensurately increased and the economic applications to which such cards can then be applied is correspondingly limited. Typically,

such prior art proximity cards will have a manufacturing cost of several dollars per card.

Furthermore, whenever a printed circuit board element, carrying the security code-bearing circuit, is embedded in a plastic card, the real possibility arises for disassembling the card, extracting the printed circuit board and tampering with the security code or fabricating a counterfeit card therefrom.

What is needed, then, is a methodology for laminating a card which is inexpensive, which is flexible, durable and almost nonbreakable, which is physically integrated and simply manufacturable, and which is of a design which is tamperproof. The resulting card should be truly comparable in thickness to standard credit cards, so that it is as flexible as a standard credit card, and can be manufactured or laminated without any significant loss of function in the integrated circuits, thereby resulting in mass production of such cards at a low unit price.

## Brief Summary of the Invention

The invention is a method for manufacturing a proximity card comprising the steps of disposing a printed circuit element directly onto a core layer, and disposing an integrated circuit into a cavity defined in the core layer. The integrated circuit and printed circuit are selectively

and electrically coupled with each other. At least one additional layer of material is disposed over the printed circuit element and integrated circuit disposed on the core layer. All the layers are laminated together to form an integrated card. As a result, the printed circuit element and integrated circuit element are integrated into the laminated integrated card without substantial alteration of the structure of the card.

The cavity is precut into the core layer prior to disposition of the printed circuit element thereon.

In an alternative embodiment the cavity is cut into the core layer subsequent to disposition of the circuit element on the core layer.

The step of disposing the additional layer on the printed circuit element and integrated circuit element further comprises disposing a graphics layer on each side of the core layer and disposing a protective layer on each of the graphics layers. The core layer, printed circuit element, integrated circuit, the graphics layer and protective layers form an integrated card.

In one embodiment in the step of disposing the integrated circuit into the cavity in the core layer, the integrated circuit is entirely disposed in the cavity with little or no portion of the integrated circuit other than the leads necessary to couple the integrated circuit to the printed circuit element being exposed out of the cavity.

The invention can also be characterized as a method for fabricating a proximity card comprising the step of disposing a film on a core layer. The film carries a printed circuit element and an integrated circuit electrically coupled to the printed circuit element. The film is aligned with a cavity defined in the core layer such that when the film is disposed on the core layer, the integrated circuit is disposed on the film aligned with and into the cavity defined in the core layer. At least one additional layer of material is disposed on the film, printed circuit element and integrated circuit carried by the film. The film, core layer and at least one additional layer are laminated together to form an integrated card. As a result, the printed circuit element and integrated circuit are included within the laminated card in an integral manner without substantial structural alteration of the laminated card.

In one embodiment each of the steps is continuously performed. The film contains a plurality of printed circuit elements and corresponding integrated circuits which are coupled together. The film is disposed on the core layer as a continuous web. The core layer forms a continuous web having a corresponding plurality of cavities. One cavity corresponds to each integrated circuit carried by the continuous web of film. The additional layer is a continuous web of material disposed upon the continuous web

of film carrying the printed circuit element and integrated circuit, and is disposed upon the continuous web of core layer.

The method further comprises the step of die-cutting the integrated webs of laminated layers to form a plurality of separate cards. Each card includes one integrated circuit and printed circuit element.

Where each of the steps is continuously performed, the film is disposed on the core layer as a continuous web containing a plurality of printed circuit elements and corresponding integrated circuits which are coupled together. The core layer forms a continuous web having a corresponding plurality of cavities. One cavity corresponds to each integrated circuit carried by the continuous web of film. The one additional layer is a continuous web disposed upon the continuous web of film carrying the printed circuit element and integrated circuit and is disposed upon the continuous web of core layer.

The invention is also a laminated, integrated proximity card comprising a core layer with a cavity defined therethrough. An integrated circuit with leads is disposed in the cavity. Little or no portion of the integrated circuit, except such leads as may be connected thereto, is disposed exterior to the cavity of the core layer. A printed circuit element is disposed on the core layer and selectively electrically coupled to the integrated circuit.

At least one additional layer is disposed over the printed circuit element, integrated circuit and core layer. The one additional layer is bonded with at least the core layer to form the integrated card. As a result, a thin, flexible proximity access card is provided in which the printed circuit element and integrated circuit are integrated without substantial structural alteration of the integrated card.

The invention is still further a method of electrically accessing an integrated circuit within a laminated card having no exposed electrical contacts, but including at least one electrical pad disposed within the laminated card. The electrical pad is electrically communicated with the integrated circuit. The method comprises the steps of aligning at least one needle over the card. The needle is aligned with respect to the at least one pad disposed within the laminated card. The aligned needle is disposed into the material of the card and at least into contact with the pad. The needle and pad are then connected with each other to permit communication of electrical signals through the needle to the pad. Electrical signals are communicated through the needle to the pad and hence to the integrated circuit. The needle is then removed from the laminated card. As a result, the integrated circuit within the laminated card can be inexpensively and simply electrically

accessed for the purposes of programming the integrated circuit.

In one embodiment in the step of removing the needle from the card, a puncture hole is left in the card.

The method may in another embodiment, further comprise the step of removing the puncture hole to substantially restore the laminated card to its original configuration prior to the step of disposing the needle into the laminated card.

In one embodiment in the step of removing the puncture hole. the puncture hole is filled with a nonconductive material.

In another embodiment, in the step of removing the puncture hole from the laminated card, the puncture hole is closed by application of pressure to the card in the vicinity of the puncture hole.

The invention is also a method for manufacturing a proximity card comprising the steps of providing a printed circuit element and integrated circuit electrically coupled thereto on a core layer. The additional layer of material is softened in preparation for disposition onto the core layer, the integrated circuit and the circuit element. The softened additional layer of material is disposed over the printed circuit element and integrated circuit disposed on the core layer. All the layers are then laminated together to form an integrated card. As a result the printed

circuit element and integrated circuit element are integrated into the laminated integrated card without substantial alteration of the laminated and integrated structure of the card.

The method further comprises the step of hardening the softened layer after the softened layer is laminated to the core layer.

In another embodiment the softened layer may be an inherently soft layer of material which never hardens.

In still another embodiment the step of laminating includes embedding the integrated circuit into the softened layer.

The invention can still further be characterized as a method for fabricating a proximity card comprising the steps of providing a core layer which directly carries a printed circuit element and an integrated circuit electrically coupled to the printed circuit element. At least one additional layer of material is disposed on the core layer, printed circuit element and integrated circuit carried by the core layer. The core layer and the additional layer are laminated together to form an integrated card.

As in other embodiments, each of the steps is continuously performed. The core layer, containing a plurality of printed circuit elements and corresponding integrated circuits coupled together, forms a continuous web having a corresponding plurality of cavities. One cavity

corresponds to each integrated circuit carried by the continuous web of core layer. The additional layer is a continuous web of material disposed upon the continuous web of core layer.

The invention and its various embodiments are better visualized by viewing the following drawings where like elements are referenced by like numerals.

## Brief Description of the Drawings

Figure 1 is a diagrammatic cutaway perspective view of a proximity card built according to the invention as seen through the section lines 1-1 of Figure 3.

Figure 2 is a side sectional cutaway view of the card of Figure 1 after it has been laminated into a composite structure.

Figure 3 is a plan view of the card of Figures 1 and 2 with the upper layers removed to show the underlying antenna or loop and integrated circuit.

Figure 4 is a diagrammatic view of a web process whereby cards according to the invention may be mass manufactured.

Figure 5 is a series of diagrammatic side sectional views of a card made according to Figures 1-4 being probed and programmed according to the invention.

The invention and its various embodiments, together with its method of manufacture, may be better understood by now turning to the following detailed description.

## Detailed Description of the Preferred Embodiments

A proximity access card is fabricated in a manner such that the printed circuit element and integrated circuit within the card is integrated into a card without substantially interfering with either the physical or structural characteristics of the card. What results is a truly thin, flexible and inexpensively mass produced proximity card. The proximity card is manufactured by disposing a printed circuit element onto a core layer and placing the integrated circuit which is coupled to the printed circuit element into a cavity defined in the core layer. The cavity is defined through the core layer and completely circumscribes the integrated circuit so that little or no portion of the integrated circuit, other than its leads, are exposed above the surfaces of the core layer. A graphics layer is then disposed on each side of the core layer. The graphics layer is also disposed on top of the printed circuit element and integrated circuit disposed on the core layer. A protective layer is then disposed on the outside of each of the graphic layers. The multiple layers are then laminated by pressure and heat and/or adhesive to

form a bonded integrated card. Due to the structure and method of fabrication, there is virtually no loss of yield due to failure of the integrated circuit caused by any of the lamination steps.

In an alternative embodiment the card is made according to the above procedure by disposing a continuous film carrying the printed circuit elements and integrated circuits onto a continuous web of core material with cavities correspondingly defined therein. The graphics and protective layers are similarly continuously webs fed into a lamination press and die-cutting station.

Figure 1 is an enlarged cutaway exploded perspective view of a preferred embodiment of a proximity card manufactured according to the methodology of the invention wherein the integrated circuit and its accompanying integrated circuit element are integrated into the laminated structure of the card as opposed to being inserted or encapsulized therein. Turning first to Figure 1, it can readily be appreciated that circuit 10 is disposed within a die-cut through-cavity 12 cut into a core layer 14. Die-cut cavity 12 is better shown in the plan view of Figure 3. Core layer 14 is approximately equal in thickness to circuit 10, and may have the two-dimensional planar extent of a standard credit card. Integrated circuit 10 is disposed in cavity 12 and is supported by its electrical leads with a printed circuit element 16 shown in side view as being

disposed on the top of core layer 14. After electrical connection is made to circuit 10, it is stabilized within cavity 12 and the wiring bonded to circuit 10 is protected by placement of a nonconductive epoxy on and around circuit 10. This facilitates handling of a sheet of material with a plurality of circuits 10 therein. Printed circuit element 16 is again better depicted in the plan view of Figure 3 wherein the overlying layers disposed on core layer 14 have been removed for clarity of view.

In the illustrated embodiment of Figures 1-3, printed circuit element 16 is an antenna or loop which is directly deposited on the upper surface of core layer 14 by conventional photolithographic techniques. Core layer 14 is typically composed of a polyester or vinyl material. The copper or other metal which comprises printed circuit element 16 is deposited by conventional means on core layer 14, sensitized, exposed to a photographic pattern, and selected portions etched therefrom. Because of the possible temperature sensitivity the material of core layer 14, care must be taken to maintain the temperature of the photographic and chemical etch below the melting point of the material of core layer 14. In the case of a typical polyester or vinyl, the copper etch might be a cold etch followed by a cold drying step.

In the case of vinyl, the temperature during the method steps relating to the deposition and formation of printed

circuit element 16 is generally retained in a range so as not to distort the vinyl substrate. In the illustrated embodiment, printed circuit element 16 which is an antenna or loop, is formed on the upper surface of core layer 14, it being expressly understood that it is also well known to include printed circuit layers on both sides of a substrate or on a multiple number of such substrates or core layers with through connections provided through the thickness of the core layer(s). Therefore, it is entirely within the scope and spirit of the present invention that the antenna or loop may include a similarly formed printed circuit element on the reverse side of layer 14 to that shown in Figure 3 or multiple layers.

Once printed circuit element 16 has been formed onto the surface of core layer 14, cavity 12 is punched through layer 14 if not pre-punched and integrated circuit 10 is disposed into cavity 12. Preferably, the thickness of integrated circuit 10 is somewhat less than 0.015 inch, the thickness of core layer 14, so that integrated circuit layer 10 is entirely suspended or disposed within and protected by cavity 12. In other words, in the preferred embodiment little or no portion of the integrated circuit 10, other than leads connected thereto, extend beyond the upper or lower planar surfaces of core layer 14. It is also to be understood that circuit 10 may similarly be disposed in

whole or in part in a similar cavity defined in the opposing graphics layer 18 if desired.

Integrated circuit 10 is provided with a plurality of leads extending from the semiconductor die in which the circuit is formed. Those leads provide a means whereby the die of integrated circuit 10 can be suspended within cavity 12 and also connected to printed circuit element 16. Connection between integrated circuit 10 and printed circuit element 16 is made through conventional processes such as soldering, ultrasonic welding, wedge bonding or the like.

A thinner graphics layer 18 is then placed on one or both sides of core layer 14. Graphics layer 18 is typically 0.005-0.010 inch in thickness and has printed matter disposed on its exposed surface, that is the surface oriented away from core layer 14, such as instructions, designs, company names, and logotypes as may be desired for the identification and use of the proximity card.

A protective layer 20 is then placed outside each protective layer 18, that is on the side of graphics layer 18 oriented away from core layer 14. Protective layer 20 is thinner still and is generally 0.001-0.003 inch in thickness and is typically transparent or at least transluscent to allow the graphics, which may have been impressed or printed on graphics layers 18 to be visible.

The plurality of layers now comprise a composite card, generally denoted by reference numeral 22 as best

illustrated in the side sectional view of Figure 2. The composite card 22 does in fact have a thickness 24 which is comparable to a standard credit card. Printed circuit element 16 may be slightly or entirely embedded into core layer 14 during the lamination process. The enlarged side sectional view of Figure 2 shows the assembled circuit of Figure 1 and better depicts the relationship of circuit 10 within cavity 12 to printed circuit element 16 and overlying graphics layer 18. Circuit 10 has a thickness substantially equal to the combined thickness or depth of cavity 12 and printed circuit element 16. The thickness of core layer 14 is chosen together with the thickness of circuit element 16 to approximate the thickness of circuit 10. Wires 15 are then connected between circuit 10 and printed circuit element 16 in a conventional manner. The wires are therefore disposed slightly above the upper surface of circuit 10 and printed circuit element 16 and, during the lamination process, become embedded, at least in part, into overlying graphics layer 18.

It thus may be readily appreciated from Figure 2 that the integrated circuit and its associated printed circuit element have been virtually integrated into the composite structure of card 22 with no substantial or material disruption or interference of the lamination or the composite structure of the card itself. The assembled composite, as shown in Figure 2, is processed by

conventional means typically by application of heat and/or 300-400 psi lamination pressure exerted on card 22 across opposing layers 20 and all intervening layers. It can also be readily appreciated that during hot pressing, virtually no pressure or stress is applied to integrated circuit 10 which is housed entirely within cavity 12 cut into core layer 14.

Even if the card is not laminated by roll laminating or hot pressure laminating, but is laminated through an adhesive, the integrated circuit and printed circuit element are so integrated within the card, that printed circuit element 16 is substantially characterized by the elasticity of layers 14, 18 and 20. There is much less limitation placed upon the bending of the card due to printed circuit 16 as is typical of the prior art, namely by the limited flexibility of a glass printed circuit board subject to fracture. Indeed, card 22 may be bent to the limitations of the materials from which it is fabricated and beyond before the failure of printed circuit element 16 is expected. Moreover, there is virtually no significant reduction in yield due to loss of function of integrated circuit 10 suffered during the lamination process. The yield during lamination is thus nearly 100% and the per unit cost of the card does not significantly increase due to waste or loss of materials during the lamination process.

Turn now to Figure 4, wherein one method of manufacturing the cards of Figures 1-3 is diagrammatically shown as a continuous web process. A roll 26 of material or film 28 carries integrated circuit 10 and printed circuit element 16 on a thin film 28 similar in size and construction to photographic film. However, acetate or photographic film is not necessarily used but a plastic material such as polyester or vinyl film is employed, which is bondable to materials used within the card. Thus, the embodiment of Figure 4, as opposed to the embodiment of Figures 1-3, contemplates the formation and electrical coupling of integrated circuit 10 and printed circuit element 16 on film 28 rather than directly on core layer 14. Circuit 10 may be placed on top of film 28 or in a precut hole defined into film 28 and suspended thereacross by its leads as may be desired.

The circuit bearing film 28 is continuously fed by conventional means onto a continuous web of core material 114 in which prepunched cavities 112 have been defined. Film 28 is aligned and synchronized such that printed circuits 10 are registered with cavity 112 as film 28 is laid upon core layer 114. As film 28 is being laid on core layer 114 as diagrammatically depicted in Figure 4, also simultaneously therewith are laid appropriately prepared graphics layers 118 and protective layers 120. Layers 114, 118 and 120 perform the same functions and are related to

each other in an analogous fashion to the corresponding layers 14, 18 and 20, respectively, of the embodiment of Figures 1-3.

Layer 114, film 28 and layers 118 and 120, having thus been assembled to form a composite sandwich according to the teaching of Figures 1-3, are conveyed in a continuous process to a lamination press diagrammatically shown in Figure 4 and generally denoted by reference numeral 122. While in press 122 the multiple layers just described are pressed to form a bonded or laminated composite similar to that shown and described in connection with Figure 2.

The laminated web continues to a die cutting station diagrammatically depicted in Figure 4 and generally denoted by reference numerals 124. The perimeter of the card is then cut from the continuous web of laminated material and is die-cut, resulting in the finished proximity access cards 126 again diagrammatically depicted in plan view in Figure 4 as issuing in a continuous process from the manufacturing line depicted in Figure 4.

The embodiment of Figure 4 has been described as a continuous web process, but the methodology of manufacture which contemplates the use of a circuit bearing film 28, whether in the form of a roll or as individual plates or carriers, could also be utilized in a discrete lamination process where each card is separately fabricated in an

analogous fashion to that suggested in connection with the embodiment of Figures 1-3.

Figure 5 is a simplified and highly enlarged series of five sectional views of a circuit devised according to the methodology and structure as depicted in connection with Figures 1-4. Integrated circuit 10 is probed by a plurality of needles 30, one of which is shown in Figure 5. Each needle may have a thickened shank 32 and a conical or tapered thin point 34.

In step 1 of the illustration of Figure 5, needle 30 is shown poised above protective layer 20 and is about to be inserted through layers 20 and 18 into a conductive pad which was part of printed circuit element 16.

In step 2 in Figure 5 needle 30 has been fully inserted into card 22 so that needle point 34 has made at least a partial penetration into an appropriately positioned pad of circuit element 16. Needle 30 is therefore in electrical contact with the pad of circuit element 16. Therefore, electrical signals can then be communicated through needle 30 to integrated circuit 10. Although the diagrammatic depiction of Figure 5 shows only one needle 30 in contact with the pad of printed circuit element 16, it is of course contemplated that a plurality of such needles may be simultaneously inserted if desired to allow parallel input and programming of circuit 10.

In step 3 of Figure 5 needle 30 has been withdrawn from card 22 leaving puncture hole 36 through layers 20 and 16 to the pad of printed circuit element 16 which has been contacted. Since the needle tip 34 of needle 30 is very small, it is possible to leave puncture holes 36 in card 22 without any substantial effect or degradation of the card's performance or integrity.

However, if desired, puncture holes 36 can later be covered with an epoxy or filler, or as shown in step 4 of Figure 5 where hole 36 is healed by the application of heat and pressure applied through an anvil element diagrammatically depicted as element 38. Puncture hole 36 is forced by the pressure and heat of anvil 38 to close and form a completely or substantially completely repaired closure 40. Step 5 of Figure 5 shows a "healing" of layers 18 and 20 which leaves nearly no trace.

The methodology of Figure 5 provides some advantages over an alternative method, for example, of predefining holes through layers 20 and 18 to expose the contact pads of printed circuit element 16 for later temporary insertion of thin electrodes. Firstly, there is no need for careful alignment or registration of preformed or defined holes in layers 20 and 18 with underlying pads of printed circuit element 16. Instead, needles 30 need only be aligned directly with the contact pads of printed circuit element 16 or equivalently core layer 14, which can be easily

accomplished by insertion of card 22 in a jig included within a probing station in which needles 30 are fixed. This simplifies not only the programming of circuit 10 within card 22, but also the fabrication of a card 22 generally.

The embodiments thus far discussed have each contemplated the existence of a hole in a core layer or at least in an opposing relatively thick layer into which the circuit die is inserted. It is also contemplated as being within the scope of the invention that the the layer opposing the circuit die may be heated to temporarily soften the layer to allow the circuit die to be embedded into the softened layer during lamination without undue stress being exerted upon the the circuit die or other damage being caused to the die or circuit elements. Curing or cooling of the softened layer will then provide a relatively hard encasement to protect the circuit die.

A process similar to that of Figure 4, namely a process wherein the circuit element and circuit die is on a carrier, may also be practiced wherein film 28 is not a thin film but a thick layer similar to core layer 114 and wherein core layer 114 is deleted. In other words, the circuit die and circuit elements may be disposed directly on a roll, strip, or discrete carrier having a thickness comparable to the core layer and then laminated to additional layers without the need for core layer 114.

Many modifications and alterations may be made by those having ordinary skill in the art without departing from the spirit and scope of the invention. Therefore, the illustrated embodiment must be understood as being shown only for the purposes of example and not as limiting the invention which is defined in the following claims.

CLAIMS

1. A method for manufacturing a proximity card comprising the steps of:

disposing a printed circuit element directly onto a core layer;

disposing an integrated circuit into a cavity defined in said core layer;

selectively and electrically coupling said integrated circuit and printed circuit element with each other;

disposing at least one additional layer of material over said printed circuit element and integrated circuit disposed on said core layer; and

laminating all said layers together to form an integrated card,

whereby said printed circuit element and integrated circuit element are integrated into said laminated integrated card without substantial alteration of the laminated and integrated structure of said card.

2. The method of Claim 1 wherein said cavity is precut into said core layer prior to disposition of said printed circuit element thereon.

3. The method of Claim 1 wherein said cavity is cut into said core layer subsequent to disposition of said circuit element on said core layer.

4. The method of Claim 1 where said step of disposing said at least one additional layer on said printed circuit element and integrated circuit element further comprises disposing a graphics layer on each side of said core layer and disposing a protective layer on each said graphics layer, said core layer, printed circuit element, integrated circuit, graphics layer and protective layers forming an integrated card.

5. The method of Claim 1 where in said step of disposing said integrated circuit into said cavity in said core layer, said integrated circuit is entirely disposed in said cavity with little or no portion of said integrated circuit other than said leads necessary to couple said integrated circuit to said printed circuit element are exposed out of said cavity.

6. The method of Claim 5 wherein said cavity is precut into said core layer prior to disposition of said printed circuit element thereon.

7. The method of Claim 5 wherein said cavity is cut into said core layer subsequent to disposition of said circuit element on said core layer.

8. A method for fabricating a proximity card comprising the steps of:

disposing a film on a core layer, said film carrying a printed circuit element and an integrated circuit electrically coupled to said printed circuit element, said film aligned with a cavity defined in said core layer such that when said film is disposed on said core layer, said integrated circuit disposed on said film is aligned with and into said cavity defined in said core layer;

disposing at least one additional layer of material on said film, printed circuit element and integrated circuit carried by said film; and

laminating said film, core layer and at least one additional layer together to form an integrated card,

whereby said printed circuit element and integrated circuit are included within said laminated card in an integral manner without substantial structural alteration of said laminated card.

9. The method of Claim 8 where each of said steps is continuously performed, said film containing a plurality of printed circuit elements and corresponding integrated

circuits coupled together, said film being disposed on said core layer as a continuous web, said core layer forming a continuous web having a corresponding plurality of cavities, one cavity corresponding to each integrated circuit carried by said continuous web of film, and said at least one additional layer being a continuous web of material disposed upon said continuous web of film carrying said printed circuit element and integrated circuit, and upon said continuous web of core layer.

10. The method of Claim 9 further comprising the step of die-cutting the integrated webs of laminated layers to form a plurality of separate cards, each card including one integrated circuit and printed circuit element.

11. The method of Claim 8 where said step of disposing said at least one additional layer further comprises disposing a graphics layer on each side of said core layer and a protective layer on each graphics layer opposite said core layer, and where in said step of laminating, said core layer, printed circuit element, graphics layers and protective layers are laminated into said integrated card.

12. The method of Claim 11 where each of said steps is continuously performed, said film being disposed on

said core layer as a continuous web containing a plurality of printed circuit elements and corresponding integrated circuits coupled together, said core layer forming a continuous web having a corresponding plurality of cavities, one cavity corresponding to each integrated circuit carried by said continuous web of film, and said at least one additional layer being a continuous web disposed upon said continuous web of film carrying said printed circuit element and integrated circuit and upon said continuous web of core layer.

13. The method of Claim 12 further comprising the step of die-cutting the integrated web of laminated layers to form a plurality of separate cards, each card including one integrated circuit and printed circuit element.

14. A laminated, integrated proximity card comprising:

a core layer with a cavity defined therethrough;

an integrated circuit having leads disposed in said cavity, little or no portion of said integrated circuit, except said leads, being disposed exterior to said cavity of said core layer;

a printed circuit element disposed on said core layer and selectively electrically coupled to said integrated circuit; and

at least one additional layer disposed over said printed circuit element, integrated circuit and core layer, said at least one additional layer being bonded with at least said core layer to form said integrated card,

whereby a thin, flexible proximity access card is provided in which said printed circuit element and integrated circuit are integrated without substantial structural alteration of said integrated card.

15. The card of Claim 14 wherein said at least one additional layer further comprises a graphics layer disposed on each side of said core layer and a protective layer disposed on each graphics layer on the side of said graphics layer opposite said core layer, and wherein said protective layer, graphics layer and core layers are bonded together to form said integrated card.

16. The card of Claim 14 wherein said at least one additional layer is bonded to said core layer by laminating.

17. The card of Claim 15 wherein said protective layer, graphics layer and core layer are mutually bonded together by lamination.

18. The card of Claim 14 wherein said printed circuit element and integrated circuit element are disposed directly upon and in said core layer respectively.

19. The card of Claim 14 wherein said printed circuit element and integrated circuit are disposed on a film and said film, carrying said printed circuit element and integrated circuit, are disposed on said core layer, said film being registered with said core layer so that said integrated circuit is disposed within said cavity defined in said core layer.

20. The card of Claim 19 wherein said at least one additional layer further comprises a graphics layer disposed on each side of said core layer and a protective layer disposed on each graphics layer on the side of said graphics layer opposite said core layer, and wherein said protective layer, graphics layer and core layers are bonded together to form said integrated card.

21. A method of electrically accessing an integrated circuit within a laminated card having no exposed electrical contacts, but including at least one electrical pad disposed within said laminated card, said electrical pad being electrically communicated with said integrated circuit, said method comprising the steps of:

aligning at least one needle over said card, said needle being aligned with respect to said at least one pad disposed within said laminated card;

disposing said aligned needle into the material of said card and at least into contact with said pad, said needle and pad then being connected with each other to permit communication of electrical signals through said needle to said pad;

communicating electrical signals through said needle to said pad and hence to said integrated circuit; and

removing said at least one needle from said laminated card,

whereby said integrated circuit within said laminated card can be inexpensively and simply electrically accessed for the purposes of programming said integrated circuit.

22. The method of Claim 21 where in said step of removing said needle from said card a puncture hole is left in said card.

23. The method of Claim 22 further comprising the step of removing said puncture hole to substantially restore said laminated card to its original configuration prior to said step of disposing said needle into said laminated card.

24. The method of Claim 23 where in said step of removing said puncture hole, said puncture hole is filled with a nonconductive material.

25. The method of Claim 23 where in said step of removing said puncture hole from said laminated card, said puncture hole is closed by application of pressure to said card in the vicinity of said puncture hole.

26. A method for manufacturing a proximity card comprising the steps of:

providing a printed circuit element and integrated circuit electrically coupled thereto on a core layer;

softening at least one additional layer of material in preparation for disposition onto said core layer, said integrated circuit and said circuit element;

disposing said softened additional layer of material over said printed circuit element and integrated circuit disposed on said core layer; and

laminating all said layers together to form an integrated card,

whereby said printed circuit element and integrated circuit element are integrated into said laminated integrated card without substantial alteration of the laminated and integrated structure of said card.

27. The method of Claim 26 further comprising the step of hardening said softened layer after said softened layer is laminated to said core layer.

28. The method of Claim 26 wherein said softened layer is an inherently soft layer of material and never hardens.

29. The method of Claim 27 where said step of laminating includes embedding said integrated circuit into said softened layer.

30. A method for fabricating a proximity card comprising the steps of:

providing a core layer, said layer directly carrying a printed circuit element and an integrated circuit electrically coupled to said printed circuit element;

disposing at least one additional layer of material on said core layer, printed circuit element and integrated circuit carried by said core layer; and

laminating said core layer and at least one additional layer together to form an integrated card,

whereby said printed circuit element and integrated circuit are included within said laminated card in an integral manner without substantial structural alteration of said laminated card.

31. The method of Claim 30 where each of said steps is continuously performed, said core layer containing a plurality of printed circuit elements and corresponding integrated circuits coupled together, said core layer forming a continuous web having a corresponding plurality of cavities, one cavity corresponding to each integrated circuit carried by said continuous web of core layer, and said at least one additional layer being a continuous web of material disposed upon said continuous web of core layer carrying said printed circuit element and integrated circuit.

32. The method of Claim 30 further comprising the step of die-cutting the integrated webs of laminated layers to form a plurality of separate cards, each card including one integrated circuit and printed circuit element.

33. The method of Claim 30 where said step of disposing said at least one additional layer further comprises disposing a graphics layer on each side of said core layer and a protective layer on each graphics layer opposite said core layer, and where in said step of laminating, said core layer, printed circuit element, graphics layers and protective layers are laminated into said integrated card.

34. The method of Claim 33 where each of said steps is continuously performed, said core layer being disposed on said core layer as a continuous web containing a plurality of printed circuit elements and corresponding integrated circuits coupled together, said core layer forming a continuous web having a corresponding plurality of cavities, one cavity corresponding to each integrated circuit carried by said continuous web of core layer, and said at least one additional layer being a continuous web disposed upon said continuous web of core layer carrying said printed circuit element and integrated circuit and upon said continuous web of core layer.

FIG. 1

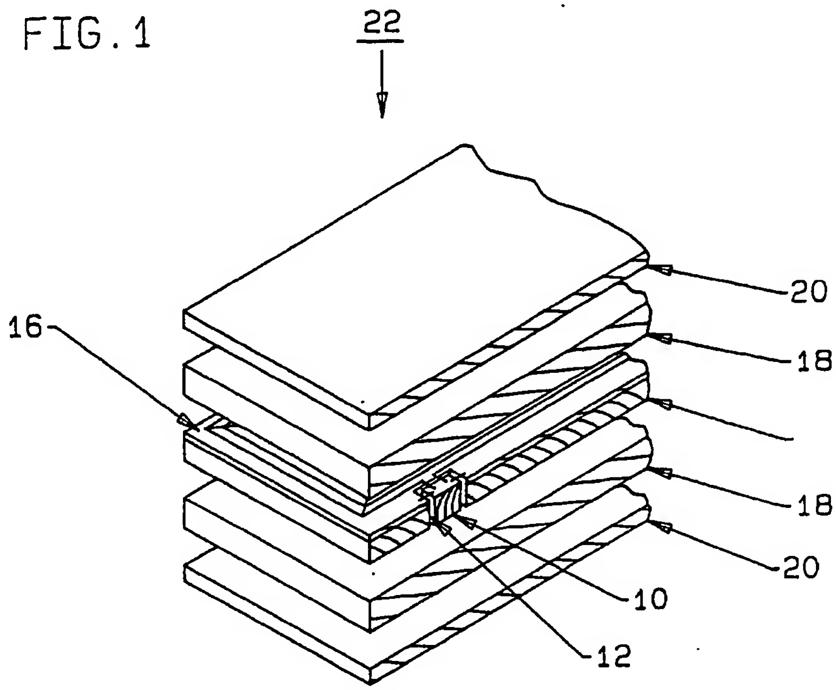
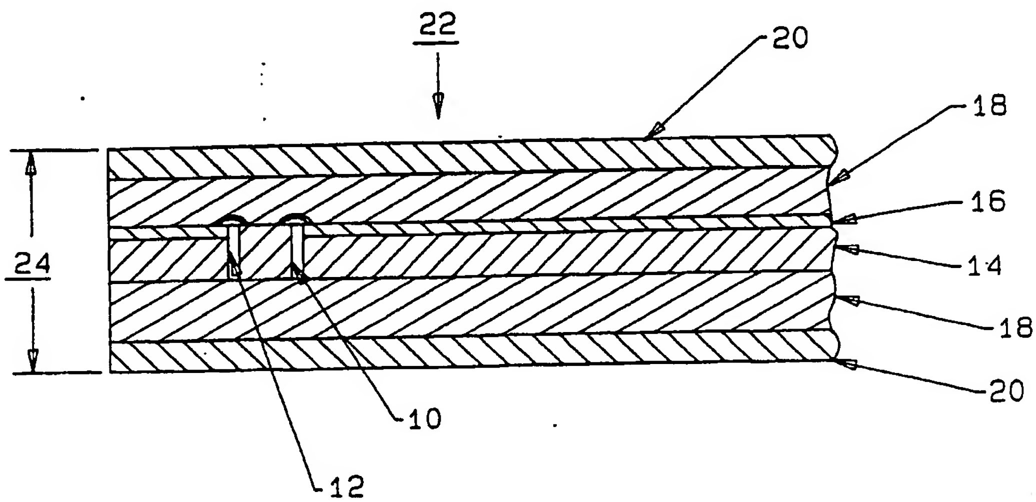



FIG. 2



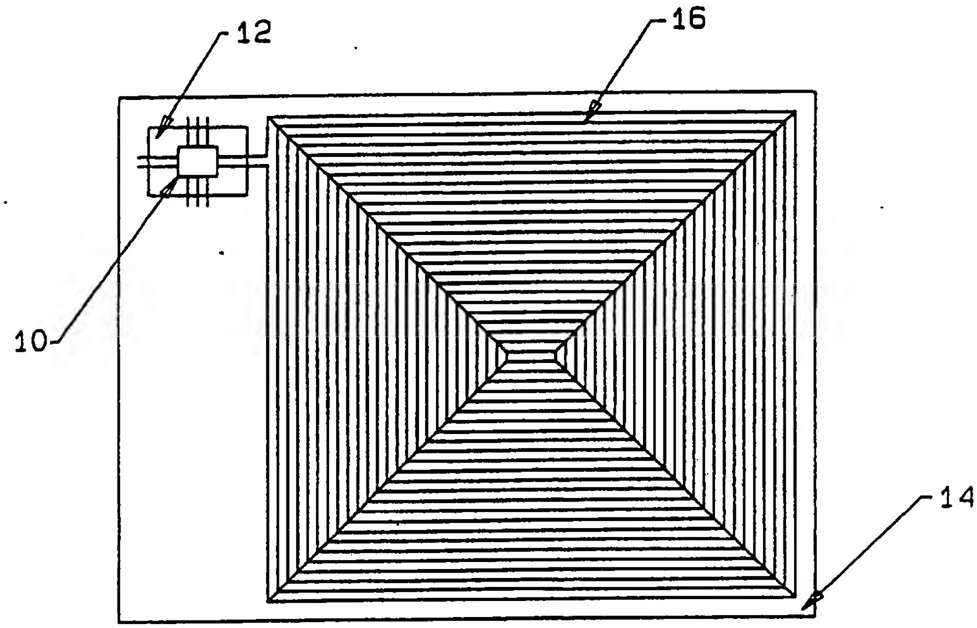
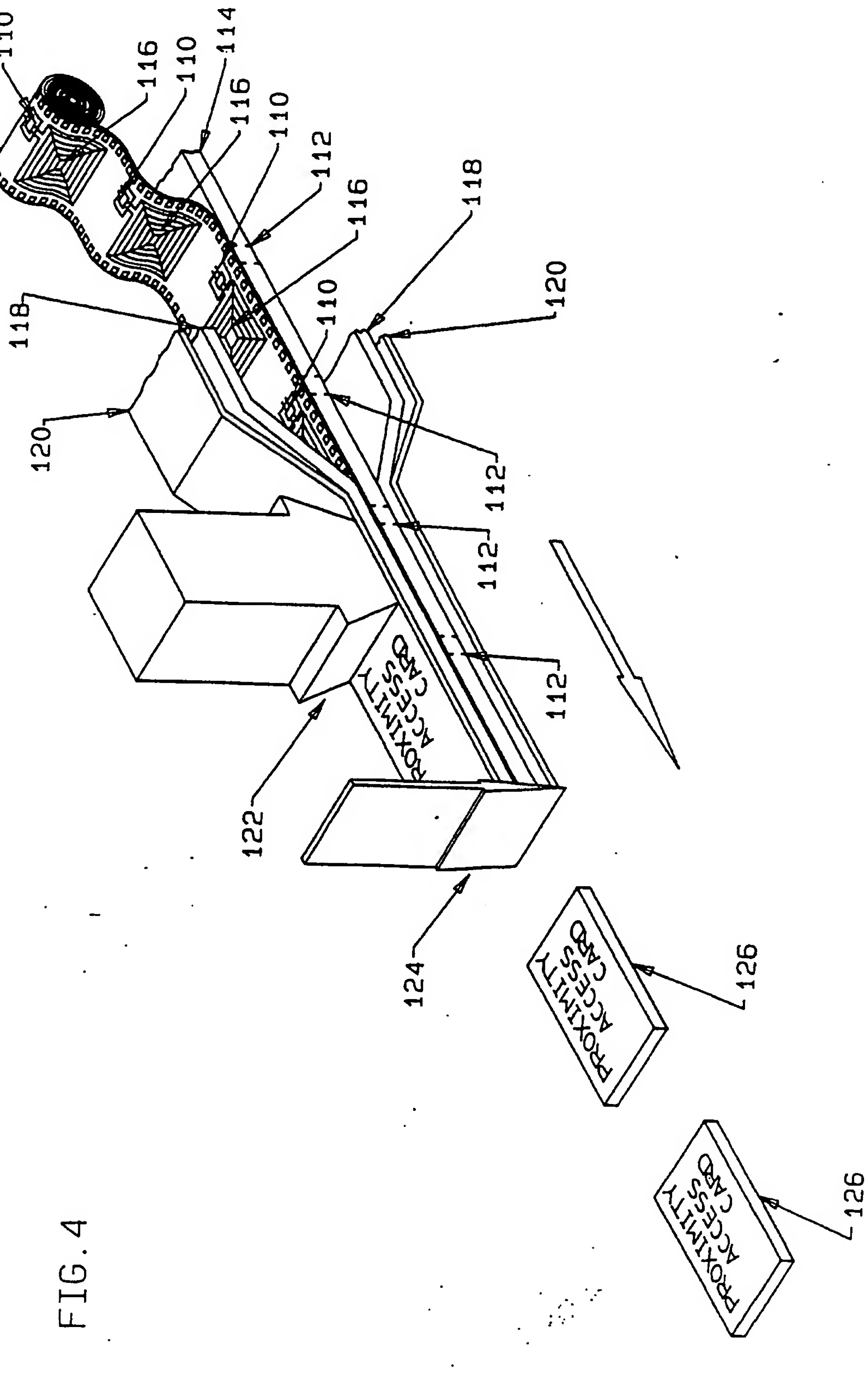



FIG.3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PROXIMITY ACCESS CARD
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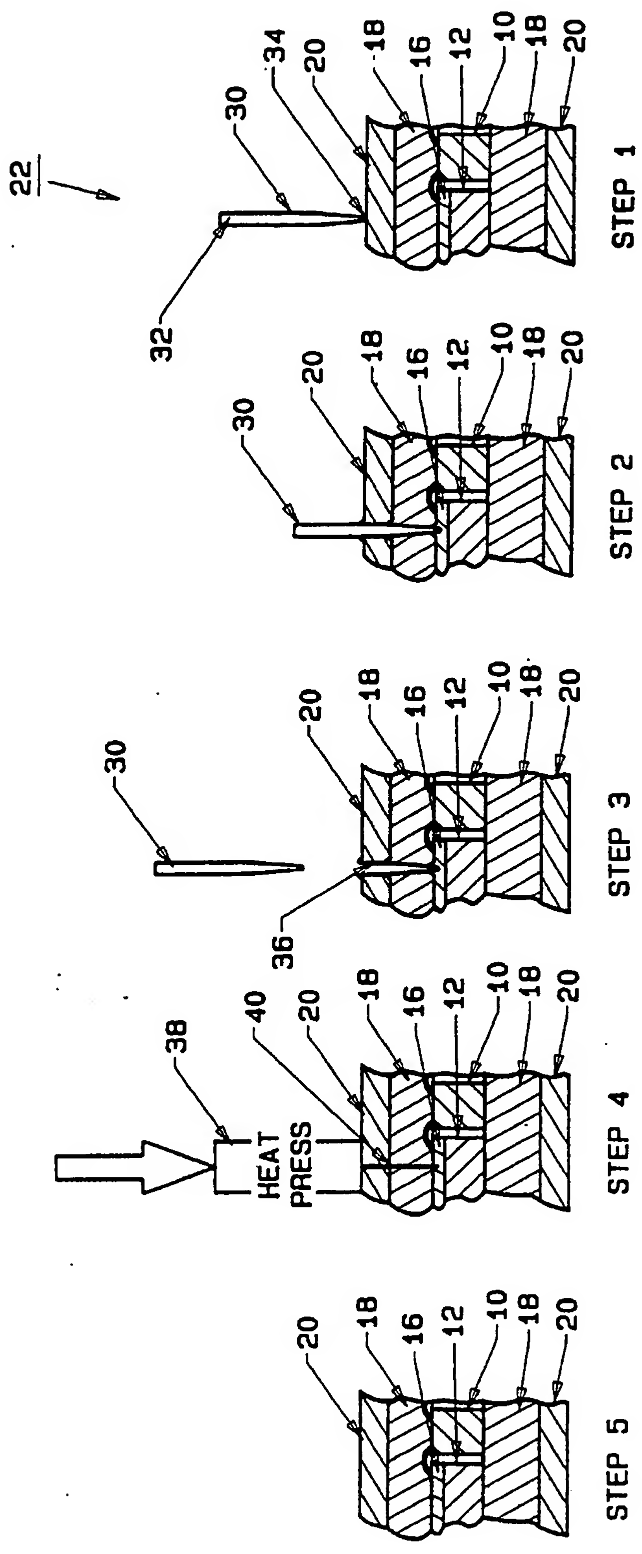
FIG.4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STEP 2
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HEAT
PRESS
STEP 4
STEP 5

FIG.5

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/01324

**I. CLASSIFICATION OF SUBJECT MATTER** (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): G06K 19/02

U.S. Cl. 235/488

**II. FIELDS SEARCHED**

Minimum Documentation Searched [7]

| Classification System | Classification Symbols |
|---|---|
| U.S. | 235/441, 487, 488, 492; 29/831, 841 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

**III. DOCUMENTS CONSIDERED TO BE RELEVANT** [9]

| Category * | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No. [13] |
|---|---|---|
| Y | US, A, 4,499,371 (ROSE), 12 February 1985, see entire document. | 21-25 |
| Y | US, A, 4,617,216 (HAGHIRI-TEHRANI ET AL.), 14 October 1986, see entire document. | 26-29 |
| Y,P | US, A, 4,668,314 (ENDOH ET AL.), 26 May 1987, see entire document. | 1-34 |
| Y, P | US, A, 4,714,980 (HARA), 22 December 1987, see entire document. | 1-34 |

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

**IV. CERTIFICATION**

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 27 JUNE 1988 | 02 AUG 1988 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| ISA/US | DAVID L. TRAFTON |

Form PCT/ISA/210 (second sheet) (Rev.11-87)